WEBER RETROFIT

3 December 1985

5993

PROJECT NAME: WEBER RETROFIT

LOCATION: Rankin Inlet,
Northwest Territories

DATE: December 3, 1985

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OBJECT

Northern communities are experiencing ongoing problems with differential settlement. The unstable soil conditions cause foundation pads to shift resulting in homes being "racked" and "torn" necessitating extensive repair and in extreme cases requiring demolition. If these buildings were placed or constructed on a rigid, torsionally stable platform then differential settlement of supports will displace or tilt the entire building. This will keep the dwellings intact and eliminate maintenance required due to structural damage from shifting foundations.

SCOPE

Central Mortgage and Housing Corporation approached Triodetic Building Products Ltd. to design and supply a substructure on which the houses would rest. The house under consideration is an existing single story duplex located in Rankin Inlet.

BACKGROUND

Triodetic Building Products Ltd. manufactures spaceframe structures using the Triodetic joint to interconnect tubular components. Triodetic is a Canadian product and was invented and developed during the early 60's. Triodetic now enjoys a worldwide reputation and is manufactured under license in many parts of the world.

A Triodetic structural connection consists essentially of two parts: a structural member (usually a tube and referred to as a chord or diagonal) and extruded connector (referred to as a hub).

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A mechanical joint is made by inserting the cold formed serrated ends of the tube members into the radial matching slots of the connecting hubs. (See figure 1)

Geometric configurations are limitless. This has been demonstrated in the construction of Triodetic domes, hyperbolic shells and a variety of freeform structures.

As far as the standard spaceframes are concerned module sizes and frame depths are fabricated to suit specific dimensional criteria.

DESIGN CONCEPT

A grid layout corresponding to the overall dimensions of the building was selected. The modular configuration of the spaceframe is made up of a series of top squares separated from an offset lower grid by means of diagonals.

In order to achieve torsional rigidity each square in the top or bottom layer has horizontal diagonals bracing the square. Torsional rigidity ensures the frame has the capacity to resist bending in multiaxial directions as well as twisting moments through axial loadings in individual members.

By placing such a grid work on three supports the location of the reactions is fixed and the magnitude of these reactions can be readily determined. Vertical displacements of the footings translate into a tilting of the entire frame.

A house on three supports does put a tremendous burden on the footings as well as the structure. High stresses occur at the supports and requires the placement of reinforced members in these areas. This does call for extra care during fabrication and site assembly and detracts somewhat from overall uniformity.

Ideally it would be advantageous to keep uniformity among the components making up the spaceframe. Sizing all members to suit the conditions of maximum stress, however, would not be practical or economical. What may be considered and requires further study is to place the grid on a gravel bed. Each lower node is a potential support and the behaviour of the grid is much like a "floating" slab. Components making up the

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grid are uniform. The grid may be extended in any direction at any time without the need for redesign or reinforcing due to changes in structural behaviour. This type of construction could be applied to two storey or larger homes. The criteria for design of such a structure is most important to ensure sizing of spaceframe members is practical as well as safe.

DESIGN STUDY

A computor model of the spaceframe slab was generated. Loads were applied at the nodes to simulate the location and magnitude of the dead load and live load intensities of the superstructure, its occupants and anticipated snow loads. Loads were applied at exterior walls and at load bearing partition walls as well as uniformly distributed locations of the floor area. From this analysis tube sizes and geometric configuration were determined.

See appendix - for grid layout and a listing of the results for tube stresses and node deflection.

The governing standard for sizing spaceframe components in this application has been strength requirements rather than deflection. Due to the remoteness of the site, serious consideration was given to overall shipping weight. By keeping the spaceframe members slender deflections are anticipated. The maximum deflection under dead load and live load is 44mm. The deflection is incremental in nature starting from the single support at the center of one edge and increasing gradually toward the cantilevered ends of the frame. The magnitude of the displacement is derived from a simulated loading condition on the computer model.

It is of great interest to observe the prototype in the field to monitor the actual magnitude of the deflection and its effect on an exisiting structure.

SHIPPING/FREIGHT

The weight of the structure including timber purlins which serve as floor purlins to support the existing house is 4,500 kg. Shipping volume is 4 cubic meter with none of the crates exceeding 2 meters in length. This compact and dense shipping volume makes it ideal for

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air cargo transportation. (See figure)

INSTALLATION

Materials were delivered to the site December 4 1985 for immediate construction. The temperature in Rankin Inlet was -37° C. Existing site conditions dictated the structure be assembled directly underneath the house. The house had to be raised off the ground to allow sufficient clearance underneath to assemble the spaceframe. The five wooden beams on which the house was built were raised evenly by means of hydraulic jacks then rested on fifteen sets of cribbing. (See figure)

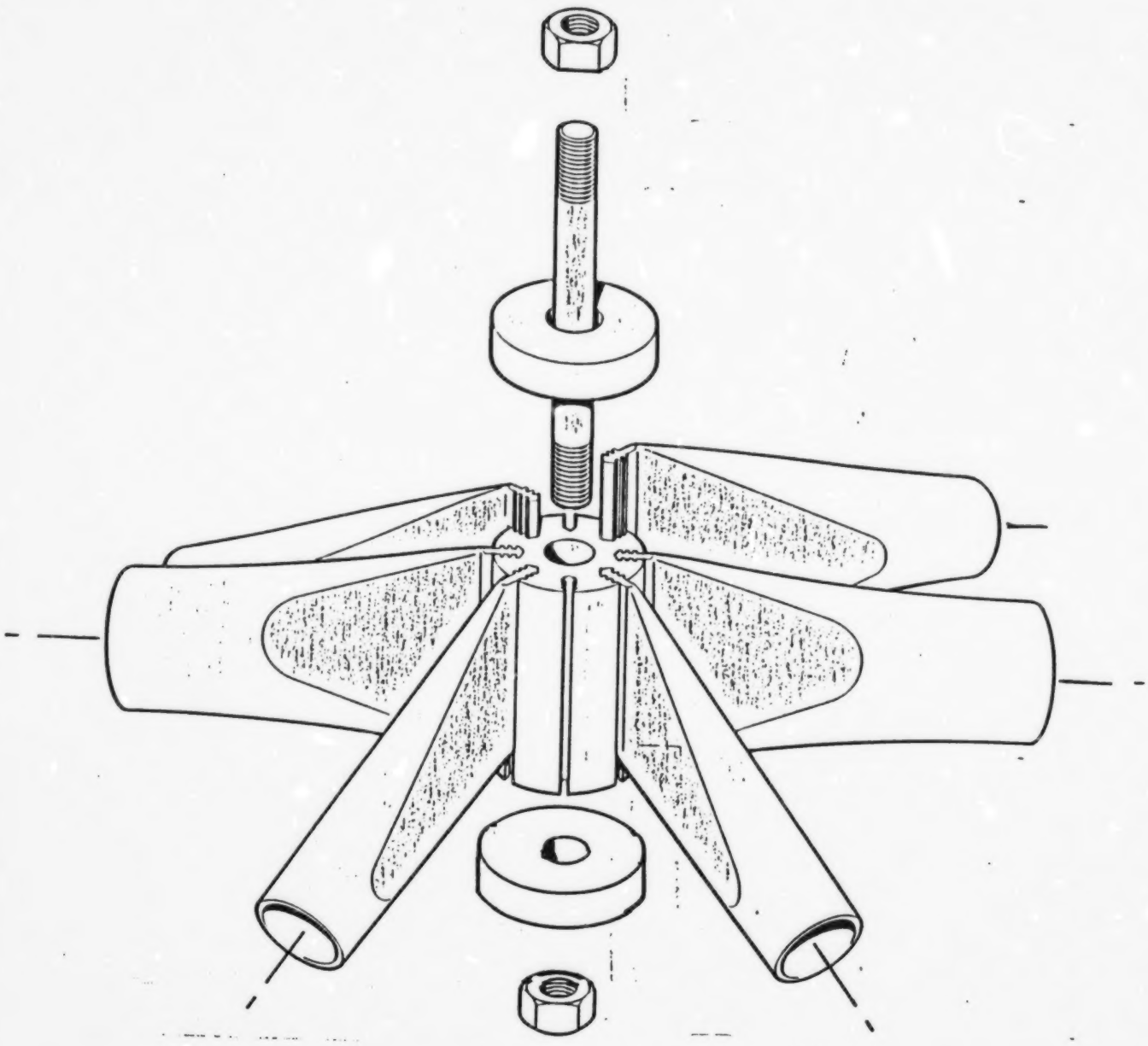
During installation some of the cribbing was replaced by timber posts to allow the assembly to proceed without obstruction from the temporary supports.

It should be noted that the available working height below the house varied from 1.2m to 1.5m. Not withstanding the adverse working conditions, progress was remarkably fast. The crew adapted very well to the assembly procedures.

Tubes are driven into the hubs by means of leather faced hammers. A single through bolt and washers complete the connection. The size and nature of the components making up a joint allow the crew to work with mitts or heavy gloves. In our experience this has been found to be a real advantage in other northern sites where the Triodetic product is used. At the time of assembly, the three jacking units were not as yet delivered to site and the spaceframe was built on eight timber pads.

After the assembly was completed, the purlins were fastened to the clips provided at the top chord. The house was then lowered onto the space-frame. The underside of the floor panels are bearing on the purlins and the existing floor beams are bearing on the top chords of the space-frame.

The entire assembly and lowering of the house was accomplished in two and one half days with three men and a working supervisor. The total number of man hours spent was 120.



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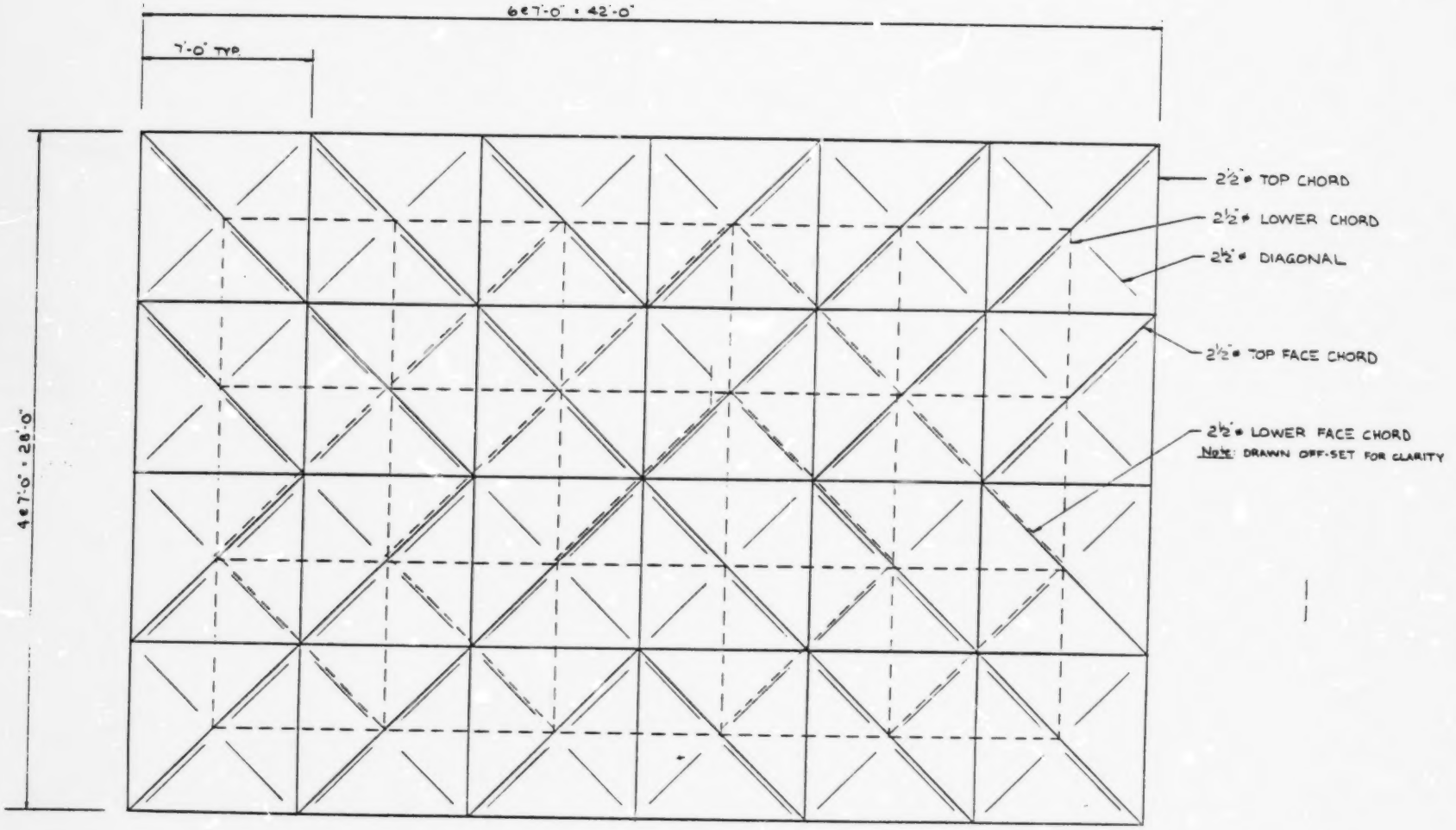
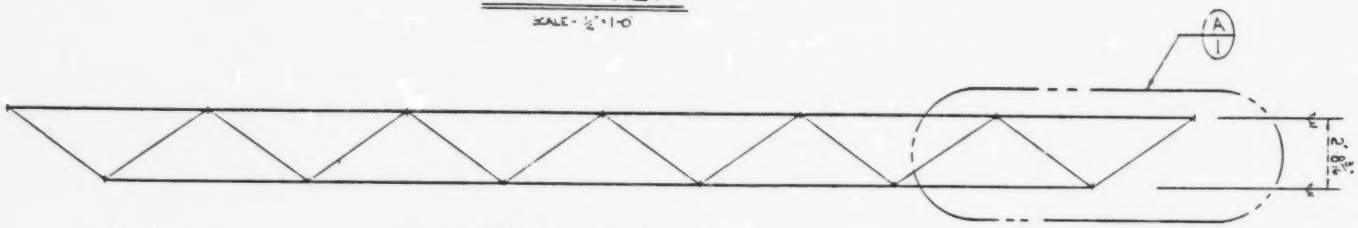
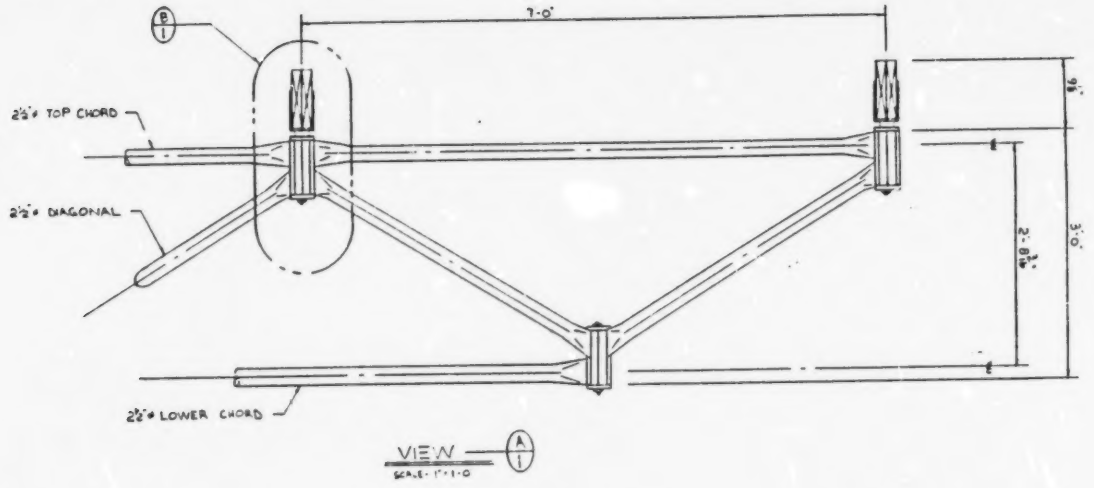


PLAN VIEW

SCALE - ½" = 1'-0

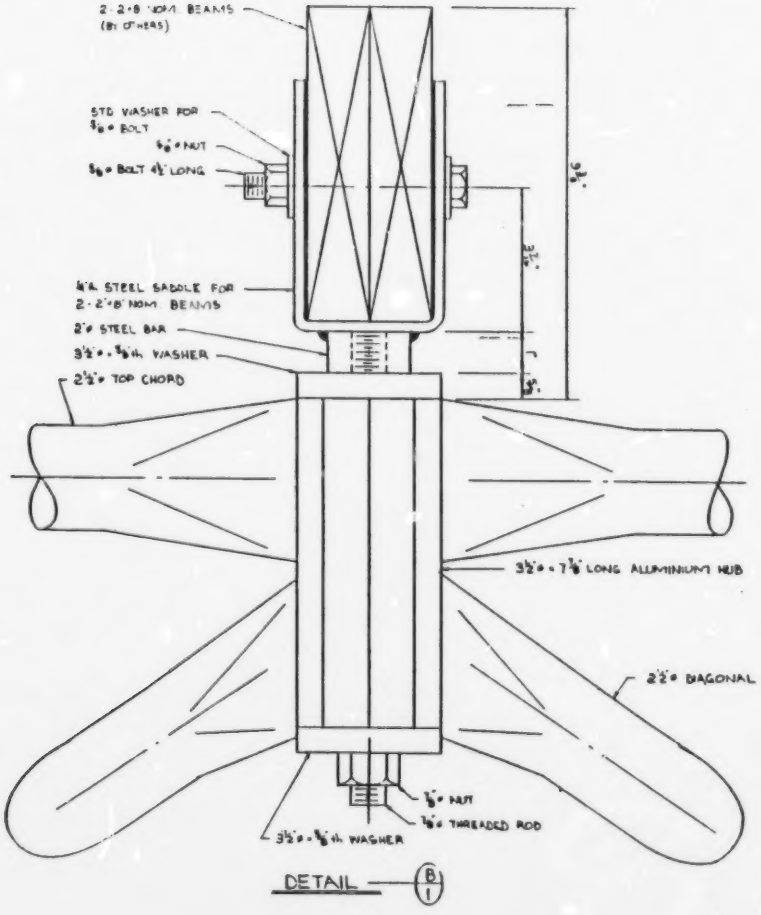


ELEVATION VIEW

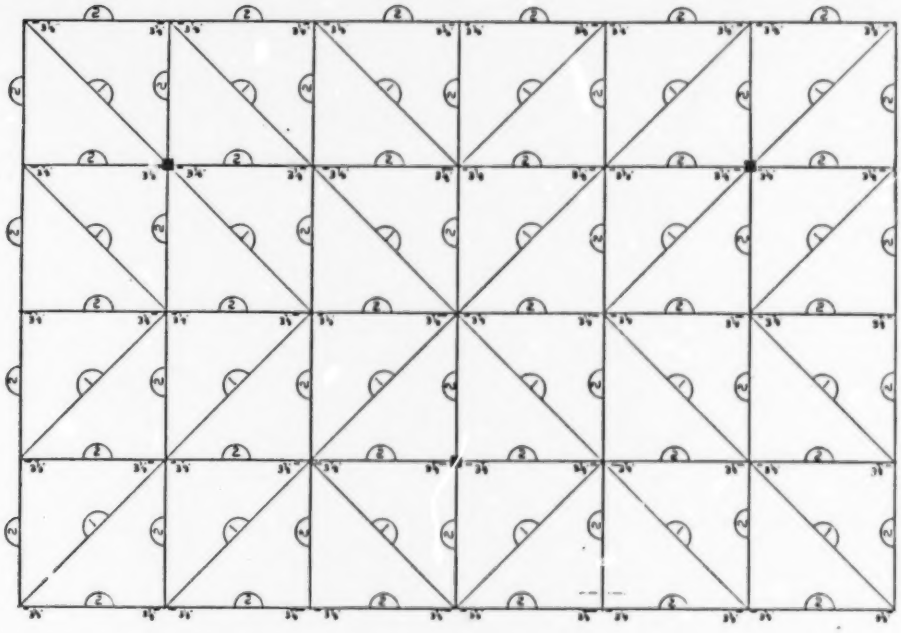


VIEW A/1

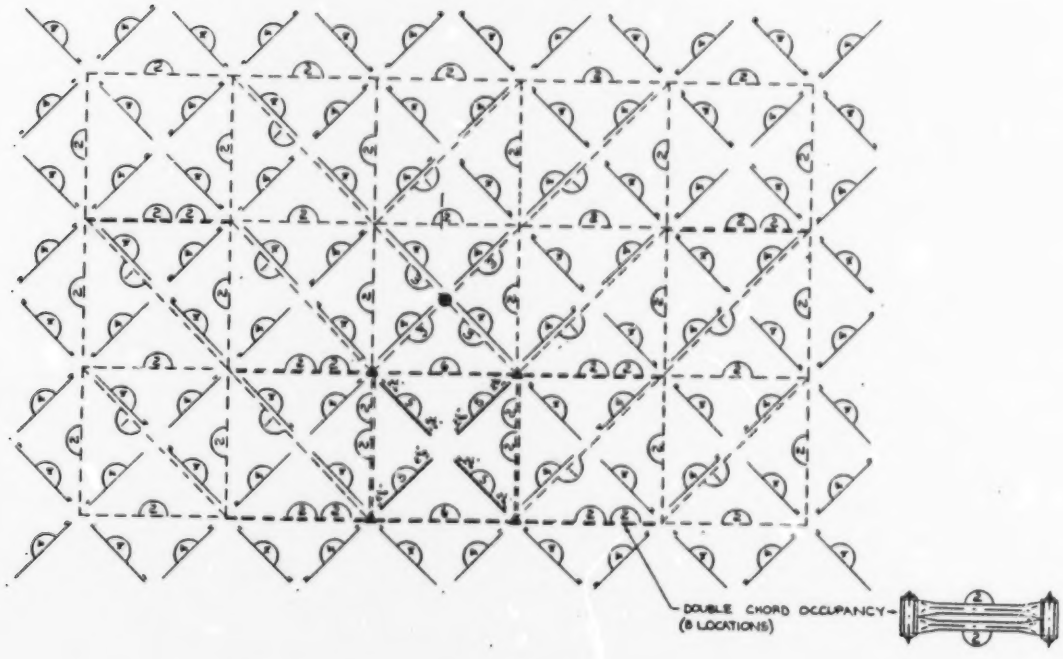
SCALE: 1" = 1'-0


2 - 2"x8" NOM. BEAMS (BY OTHERS)
STD WASHER FOR ⅝" ø BOLT
⅝" ø NUT
⅝" ø BOLT 4½" LONG
6"
3½"
3"
¼" ø STEEL SADDLE FOR 2 - 2"x8" NOM. BEAMS
2" ø STEEL BAR
3½" ø x ⅝" th. WASHER
2½" ø TOP CHORD
3½" ø x 7⅛" LONG ALUMINIUM HUB
2½" ø DIAGONAL
⅝" ø NUT
⅝" ø THREADED ROD
3½" ø x ⅝" th. WASHER

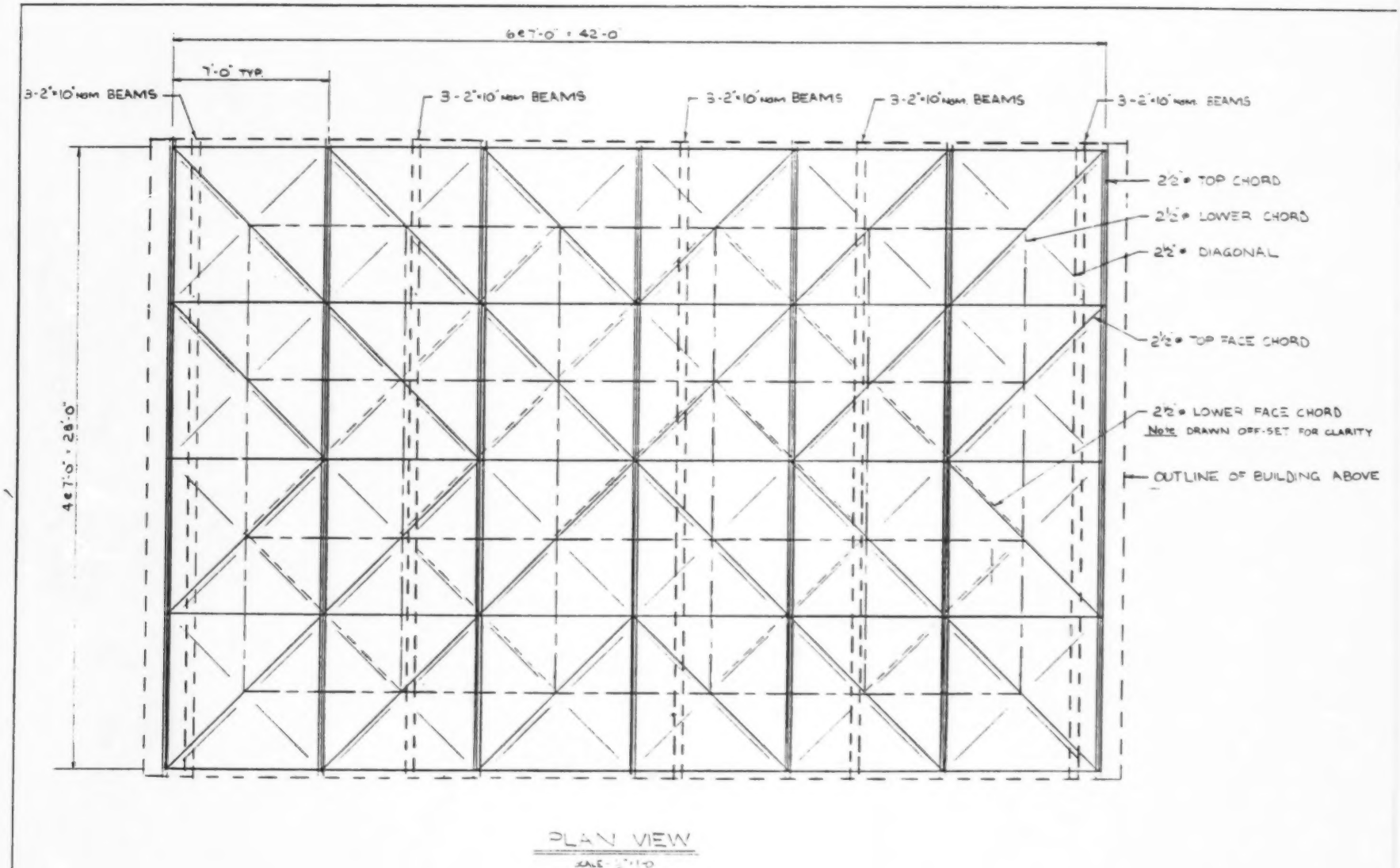
DETAIL B/1



PLAN VIEW - TOP CHORD LAYOUT



PLAN VIEW - LOWER CHORD & DIAGONAL LAYOUT



PLAN VIEW

SCALE: 1"=10'